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Rockfish Reproductive Biology Cruise (GBR-R85-1) October 21-November 9, 1985

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ABSTRACT

Leaman, B. M. and D. A. Nagtegaal. 1988. Rockfish reproductive biology cruise (GBR-R85-1), October 21-November 9, 1985. Can. Data Rep. Fish. Aquat. Sci. 716: 36 p.

Preliminary results of a research cruise to collect reproductive biology, genetic, and gill parasite data from five stocks of Pacific ocean perch (Sebastes alutus) in B.C. waters are presented. The cruise sampled stocks off southwest Vancouver Island, in Queen Charlotte Sound, Hecate Strait, west Queen Charlotte Islands, and in Dixon Entrance. Mean round and ovary weights, length at maturity, and ocean temperature data are presented. Length-weight regressions are compared with a similar cruise in 1982.

RÉSUMÉ

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Ce rapport donne les résultats préliminaires obtenus à la suite d'une croisière de recherche visant à recueillir des données sur la biologie de reproduction, la génétique et les parasites branchiaux de cinq stocks de sébastes (Sebastes alutus) dans les eaux de la C.-B. Des échantillons ont été prélevés au S.-O. de l'île Vancouver, dans le détroit de la Reine-Charlotte, dans le détroit d'Hégate, à l'ouest des îles de la Reine-Charlotte et dans l'entrée Dixon. Le rapport présente également des données sur le poids brut moyen du poisson, la longueur à la maturité, le poids moyen des ovaires et les températures de l'océan, ainsi qu'une comparaison entre les régressions longueur-poids et celles constatées au cours d'une croisière semblable faite en 1982.

INTRODUCTION

In 1982 the Rockfish Program at the Pacific Biological Station began investigation of the reproductive biology of a long-lived rockfish, Pacific ocean perch (Sebastes alutus). A portion of this study involves estimation of age and size-specific reproductive characteristics (fecundity, oocyte size, maturity, etc.) and their inter-annual variation. The cruise reported on here followed the pattern of an earlier cruise (Leaman et al. 1985) and collected samples from five stock units off the British Columbia coast, between southwest Vancouver Island and Dixon Entrance. In addition to reproductive biology samples, we also collected samples of heart, liver and muscle tissue for electrophoretic examination of protein allozymes. The five stocks sampled were from southwest Vancouver Island (VI), Goose Island Gully (GIG), Moresby Gully (MOR), Rennell Sound (RSD), and Langara Spit (LA) (Fig. 1-3). They are characterized by large differences in exploitation histories and present abundance. The uniqueness of the stock units was examined through sampling of a copepod gill parasite, Neobrachiella robusta.

In this report we present field sampling data, oceanographic observations, and length-weight relationships for Pacific ocean perch. Detailed presentation of fecundity and oocyte relationships with size and age, and genetic analysis will be presented elsewhere.

METHODS

Collections were made from the R/V G. B. REED, a 53.9 m side trawler using a Nor'Eastern bottom trawl with a 8.9 cm codend. This trawl has a 32 m footrope equipped with 46 cm bobbins on the groundline, and is rigged with three bridles to permit a large vertical opening (9.4 m). The cruise extended from October 21-November 9, 1985 and hauls were made at locations established on the previous cruise and, alternatively, at locations where commercial concentrations of S. alutus were known to occur.

Where catches were sufficiently large, samples were obtained using the method of Westrheim (1967, 1976), except that more than two tubs were extracted for each subsample due to the greater number of samples needed. Where catches were small (<1000 kg), the entire catch of S. alutus was sampled. Fish were sampled for fork length, sex, maturity, round weight, and ovary weight. Maturity was determined by the external appearance of the gonads (Table 1). The sagittal otoliths were extracted and stored in glycerine/water/thymol. Approximately 6 cm^3 of heart, liver and muscle tissue were also removed from all sampled fish and frozen at -40°C for later analysis. Ovaries were extracted, weighed and stored in either Gilson's (1897) fluid or Smith's Formal Dichromate for fecundity estimation and histological examination, respectively. Formulae for these solutions were

presented in Leaman et al. (1985). A random sample of 48 fish from each stock unit was used to verify stock identity through sampling of their gill parasite, Neobrachiella robusta.

Since growth is highly determinate for S. alutus, sampling was stratified by length to obtain adequate numbers of older fish. Age-specific sampling for rockfishes in the field is not practical because the time required for ageing the fish would be prohibitive. Sampling strata were based on previous length-age matrices (Shaw and Archibald 1981) and the allocation by length was as follows:

Length interval	Number of samples
40 cm	5
41-43 cm	10
>43 cm	20

Priority was assigned to fecundity and electrophoretic samples with surplus samples retained for histology. Weights were obtained with an electronic balance[1] to ±0.1 gm.

An additional 139 Pacific ocean perch were obtained and used for a dressed-round conversion rate study. Several body measurements of round fish were taken, the fish dressed (head and viscera removed), frozen at -20°C, and the measurements re-taken after the fish were thawed, at a later date.

Length-weight data were transformed and compared to the theoretical relationship:

$$\log W = \log a + b \log L \quad (\text{i.e., } W = aL^b).$$

Maturity ogives were constructed for each stock and size at first maturity was taken as the size at which 50% of the individuals were mature ($L_{.50}$).

Temperature observations were made at standard stations (Fig. 4-5) using expendable bathythermographs (XBTs).

RESULTS

HAUL LOCATIONS AND CATCHES

A total of 16 hauls (Fig. 1-3) for reproductive biology and tissue sampling were made between October 23-November 5, 1985. Sampling extended between depths of 201-357 m, with the majority of the S. alutus catch originating between 250-300 m. An additional four hauls were made off

[1]K-Tron DP-1, K-Tron Arizona, Scottsdale, Arizona 82560

southwest Vancouver Island to obtain lingcod samples for another investigation (Fig. 1). By the nature of the sampling objectives, S. alutus was the single largest contributor to the total catch (Table 2). Detailed catch and haul data are contained in Appendix Table 1.

BIOLOGICAL SAMPLING

The primary emphasis of sampling was the replication of 1982 ovary sampling, however tissue sampling for electrophoresis also received attention. The imbalance of electrophoretic and ovary samples (Table 3) resulted from a long delay in processing some of the Goose Island Gully ovary samples. An additional set of tissue samples was collected for this area on the day following the initial sampling, out of concern for the quality of those tissue samples originally collected. A total of 853 ovaries were collected, of which 250 were retained solely for histological examination. Sampling of fish from each stock for their gill parasites was uniform (96 individuals).

As with the previous cruise, we experienced problems with obtaining precise weight measurements under normal sea conditions, and all weighing required travel to calmer water. This travel limited the total sampling opportunities during the cruise.

The average weights of males and females (Tables 4-6) show differences from the 1982 samples, which were collected approximately one month later in the year (Leaman et al. 1985). With the exception of the Moresby Gully sample, females were generally lighter at length in 1985, compared with 1982. The exponent 'b' of the male weight-length relationship ($W=aL^b$) of the Vancouver Island stock in 1985 (2.257) departs substantially both from the theoretical value of 3.0 and the 1982 value of 2.877 (Table 7). However, the estimated value of 'a' in this relationship was an order of magnitude greater in 1985, resulting in only minor changes in predicted weight at length. No cause for this difference is immediately apparent. The general tendency of females to have smaller round weights at length in 1985 is a reflection of the earlier stage of development of the oocyte complement, hence lower ovary weights.

Length at maturity differed little between 1982 and 1985 (Table 8). Fish appear to mature rapidly with size, generally over a range of 33.5-34.5 cm which, given the normal growth rate of the species, implies a maturation period of one year. While growth rate changes in response to exploitation have been demonstrated for this species, the fixed size at maturity observed among stocks of varied exploitation history implies developmental or environmental constraints on the maturation process.

Parasite samples were analyzed to determine if adult groups of S. alutus delimited by exploitation history could be considered as distinct stocks from a management perspective. The results of this analysis were reported by Leaman and Kabata (1987) and indicated that adult fish from the

five 'stocks' do not mix. Stanley and Otterdyks (1987) have presented the results of the dressed-round conversion rate experiment. The results of fecundity and oocyte sampling will be reported separately.

OCEANOGRAPHIC DATA

Surface and bottom temperatures off the west coast of Vancouver Island ranged from 9.2-13.0°C and 4.5-9.2°C, respectively (Table 9). Off the west coast of the Queen Charlotte Islands the respective ranges were 8.4-9.2°C and 5.5-6.8°C. Most fishing took place in depths where bottom temperatures were between 5.5 and 6.5°C.

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Table 1. Description of rockfish maturity stages.

Maturity code		Gonad condition
FEMALES		
1	Immature	translucent, small
2	Maturing - small	small, yellow eggs; translucent or opaque
3	Maturing - large	large yellow eggs; opaque
4	Fertilized	large orange-yellow eggs; translucent
5	Embryos	includes eyed eggs
6	Spent	large flaccid red ovaries; residual embryos
7	Resting	moderate size and form; red-grey colour
MALES		
1	Immature	translucent, string-like
2	Maturing	swelling, brown-white colour
4	Mature	large, white; easily broken
5	Ripe	running sperm
6	Spent	flaccid, red colour
7	Resting	ribbon-like; small; brown colour

Table 2. Total catch by species, R/V GB REED, October 21-November 9, 1985.

Species name	Weight (g)	Percent
Sebastes alutus	8671	46
S. proriger	2203	12
Atheresthes stomias	2001	10
Anoplopoma fimbria	1250	7
S. brevispinis	734	4
S. zacentrus	646	3
Ophiodon elongatus	518	3
S. reedi	496	3
Sebastolobus alascanus	471	3
Squalus acanthias	312	2
Microstomus pacificus	284	2
S. babcocki	221	1
S. borealis	226	1
Others[1]	947	3
TOTAL	18,980	100

[1]Includes all species that comprised <1% of the total catch.

Table 3. Pacific ocean perch biological samples collected during R/V G.B. REED cruise, October 21-November 9, 1985.

AREA	SAMPLE TYPE AND NUMBER OF FISH				
	Gilsons[1]	Smiths[2]	Tissues[3]	Gill Rakers[4]	Otoliths[5]
Vancouver Island	139	45	219	96	363
Goose Island Gully	121	49	501	96	599
Moresby Gully	132	56	250	96	357
Rennell Sound	141	59	216	96	320
Langara Spit	80	41	158	96	317
TOTAL	613	250	1344	480	1956

[1]Ovaries preserved in Gilson's (1897) fluid for fecundity counts
[2]Ovaries preserved in Smith's Formal Dichromate for histology
[3]Heart, muscle, and liver tissue for electrophoretic analysis
[4]Gill rakers collected for parasite analysis
[5]Length-sex-maturity-double otolith sample

Table 4. Statistics of round weight (RDWT, gm) for male Pacific ocean perch, by stock, R/V G. B. REED October 21-November 9, 1985.

	MALES														
	Langara			Rennell Sd.			Moresby Gully			Goose Is. Gully			Vancouver Is.		
Length	N	RDWT	S.E	N	RDWT	S.E.	N	RDWT	S.E	N	RDWT	S.E.	N	RDWT	S.E.
15															
16															
17															
18							1	80							
19															
20															
21															
22				1	156		1	150							
23															
24				1	200										
25							1	214							
26							4	244	7.29				1	250	
27				1	264		3	266	6.89						
28							10	315	7.82						
29							2	358	17.00						
30				1	357		10	386	6.54						
31	1	427		1	447		11	423	11.61						
32				1	645		1	466							
33				1	436		1	482					2	532	3.00
34	5	514	6.66	1	562		2	617	15.50	4	567	9.47	5	632	14.11
35	11	574	9.65	8	599	14.56	1	602		8	607	8.70	3	596	26.93
36	10	617	16.20	15	617	6.98	3	664	37.71	9	639	14.88	3	669	20.22
37	7	658	6.01	10	673	10.31	1	772		11	683	10.11	1	713	59.50
38	11	727	12.86	8	722	15.59	4	764	29.73	20	736	9.94	13	805	10.22
39	16	780	9.48	8	782	18.23	1	797		33	816	10.52	23	852	11.86
40	9	836	10.86	7	917	23.47	3	940	40.15	27	883	10.92	16	883	14.80
41	4	934	26.77	8	950	30.27	9	1058	21.99	14	941	11.72	8	959	16.26
42	2	975	99.00	6	1008	26.99	4	1050	30.59	4	990	34.69	3	974	17.02
43				2	1095	22.50	1	1144		2	1094	46.50	1	653	
44				5	1135	23.00	1	1395							
45				1	1138										
46															
47															
48				1	744										
49															
50															

Table 5. Statistics of round (RDWT) and ovary weight (OVWT) (gm) for northern Pacific ocean perch stocks, R/V G. B. REED, October 21-November 9, 1985.

	FEMALES													
	Langara Spit					Rennell Sound					Moresby Gully			
Length	N	RDWT	S.E.	OVWT	S.E.	N	RDWT	S.E.	OVWT	S.E.	N	RDWT	S.E.	OVWT	S.E.
15															
16															
17															
18															
19											1	94			
20						1	107				1	93			
21															
22						1	150								
23											1	184			
24						1	213								
25															
26						1	241				5	252	3.91		
27															
28											3	299	11.57		
29											6	346	10.31		
30											8	388	6.82		
31											7	435	12.24		
32						2	466	29.00	2.0		6	469	8.78		
33						2	471	25.00			1	463			
34						7	550	13.25	3.8	.25	4	555	14.63	8.0	3.00
35	5	644	22.00	10.0	1.78	9	654	26.77	9.8	1.13	12	596	9.06	5.9	1.19
36	10	664	12.77	12.1	.88	15	649	8.62	10.0	1.36	10	644	14.87	4.9	.71
37	22	704	9.36	12.8	1.44	10	729	14.01	14.8	3.29	11	689	12.82	7.9	1.30
38	21	761	10.38	17.9	2.87	16	767	11.01	15.3	1.20	10	764	7.67	10.2	1.87
39	13	832	21.31	21.3	1.97	14	835	24.86	20.0	2.86	4	870	46.90	16.8	5.87
40	14	883	19.16	30.3	2.22	10	935	24.63	42.9	6.72	12	963	28.00	27.8	3.06
41	14	968	13.20	30.3	2.20	16	1018	23.59	46.2	5.75	15	1037	18.83	33.1	3.27
42	15	1032	20.15	35.5	3.22	17	1175	37.03	62.5	6.40	16	1137	18.46	36.0	2.88
43	16	1114	19.38	37.3	2.89	17	1226	24.73	68.2	5.81	16	1240	24.86	39.6	3.33
44	14	1210	33.91	41.6	2.63	26	1287	17.51	70.7	4.40	25	1272	14.52	41.8	2.86
45	5	1278	27.42	44.8	3.88	26	1425	21.59	77.7	2.89	25	1350	14.61	43.8	2.96
46	1	1515		64.0		24	1498	26.84	72.2	3.82	25	1443	21.26	54.4	2.40
47						5	1540	48.47	71.4	8.01	10	1568	47.14	53.9	3.04
48						10	1730	41.51	84.4	6.42	1	1596		61.0	
49						1	1995		89.0						
50						1	1873		83.0						

Table 6. Statistics of round (RDWT) and ovary weight (OVWT) (gm) for southern Pacific ocean perch stocks, R/V G. B. REED, October 21-November 9, 1985.

	FEMALES									
	Goose Is. Gully					Vancouver Island				
Length	N	RDWT	S.E.	OVWT	S.E.	N	RDWT	S.E.	OVWT	S.E.
15										
16										
17										
18										
19										
20										
21										
22										
23						1	179			
24										
25						1	179			
26										
27										
28										
29										
30	1	400								
31										
32						2	509	9.50	3.0	
33	1	550				2	598	13.50	5.5	1.50
34	3	577	32.92	5.0	2.00	5	597	24.60	8.0	.58
35	6	620	10.49	9.4	1.44	8	687	19.81	11.8	2.43
36	11	663	15.90	11.3	.63	10	731	15.72	12.2	1.63
37	10	712	14.69	15.0	2.49	10	793	11.28	14.6	1.27
38	10	844	23.08	19.1	1.22	9	959	115.46	26.6	7.19
39	9	844	14.13	26.2	1.39	7	946	54.95	28.6	5.59
40	10	910	37.92	24.6	3.06	5	1068	18.24	41.4	5.02
41	15	1005	20.88	34.0	2.19	15	1172	22.34	46.3	2.60
42	15	1079	24.60	34.1	2.87	16	1213	18.62	45.7	3.70
43	15	1186	26.78	36.1	2.24	17	1281	30.95	52.4	3.17
44	25	1241	21.54	38.8	1.81	25	1416	19.96	58.5	2.33
45	26	1340	22.37	42.6	2.69	25	1514	22.19	62.1	2.40
46	11	1495	60.56	47.4	6.19	20	1590	27.81	55.3	3.19
47	7	1558	50.89	49.6	3.84	8	1723	35.25	63.9	3.82
48	1	1752		68.0		2	1824	12.50	68.5	1.50
49										
50										

Table 7. Parameters of the length-weight relationship ($W = aL^b$) for S. alutus, by stock and sex, R/V G. B. REED October 21-November 9, 1985. Statistics are for the log-transformed relationship.

Stock	N	a	b	r^2	Residual mean square
			MALES		
Vancouver Is.	79	0.2131	2.257	0.755	0.010
Goose Is. Gully	132	0.0205	2.883	0.852	0.004
Moresby Gully	75	0.0096	3.114	0.985	0.005
Rennell Sound	87	0.0325	2.757	0.912	0.011
Langara Spit	76	0.0137	2.989	0.916	0.003
			FEMALES		
Vancouver Is.	188	0.0072	3.217	0.925	0.011
Goose Is. Gully	176	0.0177	2.949	0.868	0.012
Moresby Gully	235	0.0083	3.153	0.982	0.005
Rennell Sound	233	0.0060	3.246	0.960	0.007
Langara Spit	150	0.0154	2.974	0.897	0.005

Table 8. Length at maturity ($L_{.50}$) for female Pacific ocean perch collected during reproductive biology cruises in November 1982 and October-November 1985.

STOCK	$L_{.50}$ (cm) 1982	1985
Vancouver Island	33.5	33.0
Goose Island Gully	33.5	33.5
Moresby Gully	33.5	34.0
Rennell Sound	38.5[1]	33.5
Langara Spit	34.5	34.5

[1]Limited sampling of smaller fish

Table 9. Oceanographic data for XBT stations, R/V G. B. REED, Oct. 21-Nov. 9, 1985.

Station No.	Date (yr/mo/da)	Time (PDT)	Latitude	Longitude	Surface (°C)	Bottom (°C)	XBT Depth (M)
1	85/10/23	01:20	48°36.5	125°04.0	13.0	8.0	80
2		02:10	48°30.5	125°10.5	13.0	8.0	85
3		03:12	48°24.0	125°17.0	11.0	7.0	120
4		04:06	48°18.0	125°24.0	11.6	7.4	113
5		04:57	48°12.0	125°31.0	11.8	7.4	170
6		06:19	48°06.0	125°37.5	11.6	7.4	179
7		06:47	48°03.5	125°40.5	11.9	5.5	640
17	85/10/25	12:16	49°00.0	126°25.0	9.6	7.2	170
18		12:56	48°55.0	126°31.5	11.0	7.2	200
19		13:30	48°51.0	126°38.0	11.0	-	622
24		17:00	49°13.5	127°05.0	11.4	7.4	220
22		18:12	49°21.0	126°54.9	10.3	7.4	110
21		18:48	49°25.5	126°49.0	10.0	8.3	90
20		19:47 (PST)	49°33.5	126°38.0	11.2	8.2	90
26	85/10/27	12:33	49°51.5	127°25.0	9.9	8.1	80
27		13:15	49°47.0	127°30.5	9.8	8.2	140
28		14:05	49°42.0	127°38.0	10.2	5.6	642
30		18:20	50°21.5	128°06.5	9.7	8.5	133
31		18:57	50°18.0	128°12.5	10.0	7.0	210
32		19:51	50°13.0	128°22.0	9.7	5.4	1148
30	85/11/07	18:45	50°21.5	128°06.5	9.7	7.4	95
31		19:10	50°18.0	128°12.5	9.8	7.0	270
32		19:55	50°13.0	128°22.0	9.2	4.5	1127
27	85/11/08	00:10	49°47.0	127°30.5	9.8	7.5	90
26		00:45	49°51.5	127°25.0	9.7	8.3	71
22		04:10	49°21.0	126°55.0	12.1	6.1	139
23		04:48	49°16.0	127°01.5	9.6	6.5	166
24		05:06	49°13.5	127°05.0	11.0	5.1	485
19		16:36	48°51.0	126°38.0	9.7	4.8	585
18		17:12	48°55.0	126°31.5	9.8	6.5	178
17		17:50	49°00.0	126°25.0	10.0	7.2	140
11		20:05	48°41.0	125°58.5	10.0	8.0	95
10		20:48	48°46.0	125°50.5	10.4	9.2	80
9	85/11/08	21:29	48°50.0	125°42.0	10.0	9.0	55
1	85/11/09	00:00	48°36.5	125°04.0	9.6	8.3	95
2		00:47	48°30.5	125°10.5	10.2	7.5	120
QCI 1	85/11/03	08:55	52°40.0	132°04.1	8.6	6.4	152
QCI 2		08:58	52°40.5	132°04.8	8.7	5.7	340
QCI 3		12:54	53°04.5	132°36.0	9.0	6.5	190
QCI 4		13:07	53°04.7	132°39.5	9.2	6.0	310
QCI 4	85/11/06	20:57	53°04.7	132°39.5	9.1	5.6	330
QCI 3		21:10	53°04.3	132°04.3	8.8	5.5	189
QCI 2		23:50	52°40.5	132°04.8	8.5	6.2	219
QCI 1		23:53	52°40.5	132°04.1	8.4	6.8	162

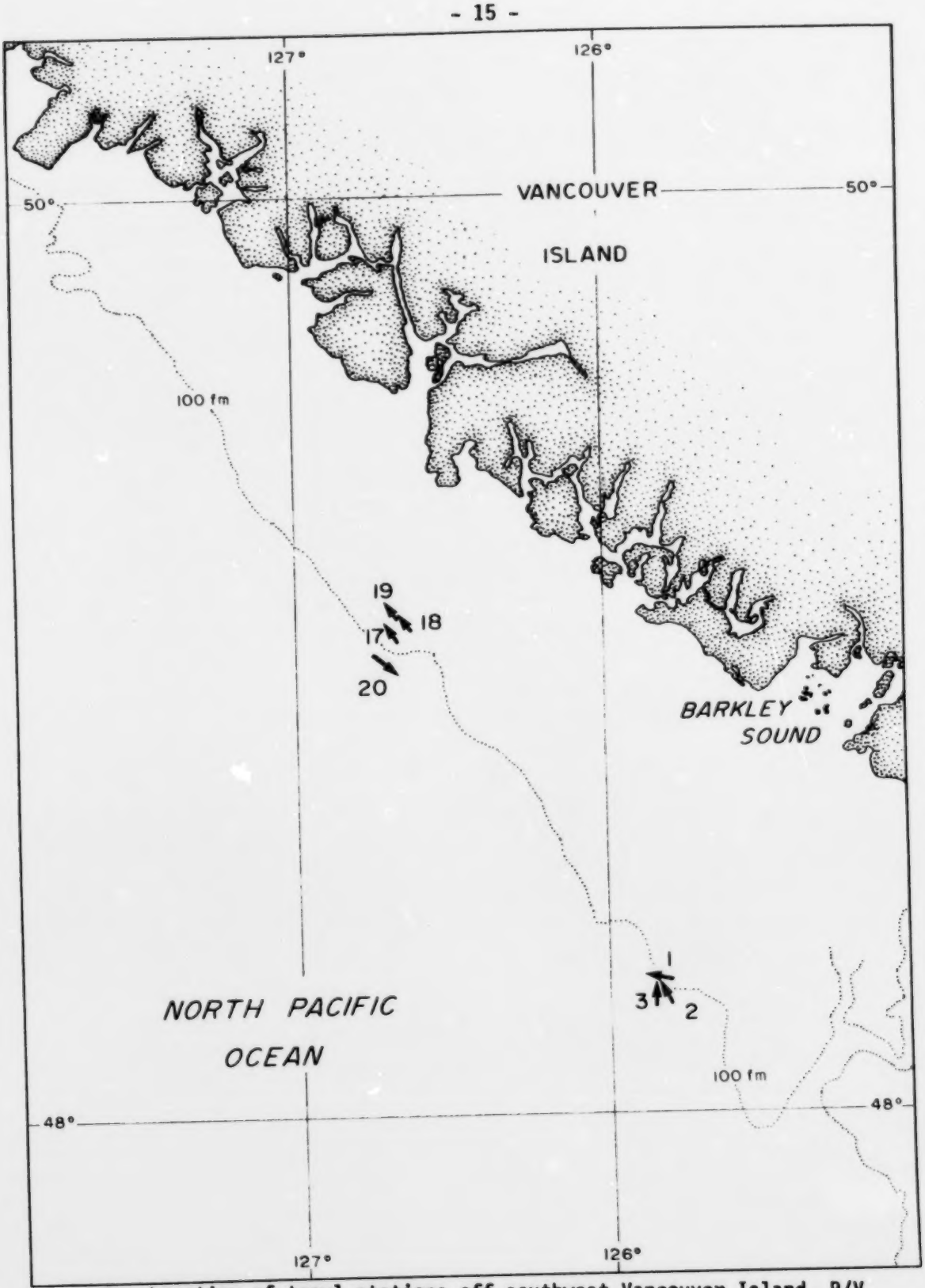

Fig. 1. Location of trawl stations off southwest Vancouver Island, R/V G. B. REED October 21 - November 9, 1985.

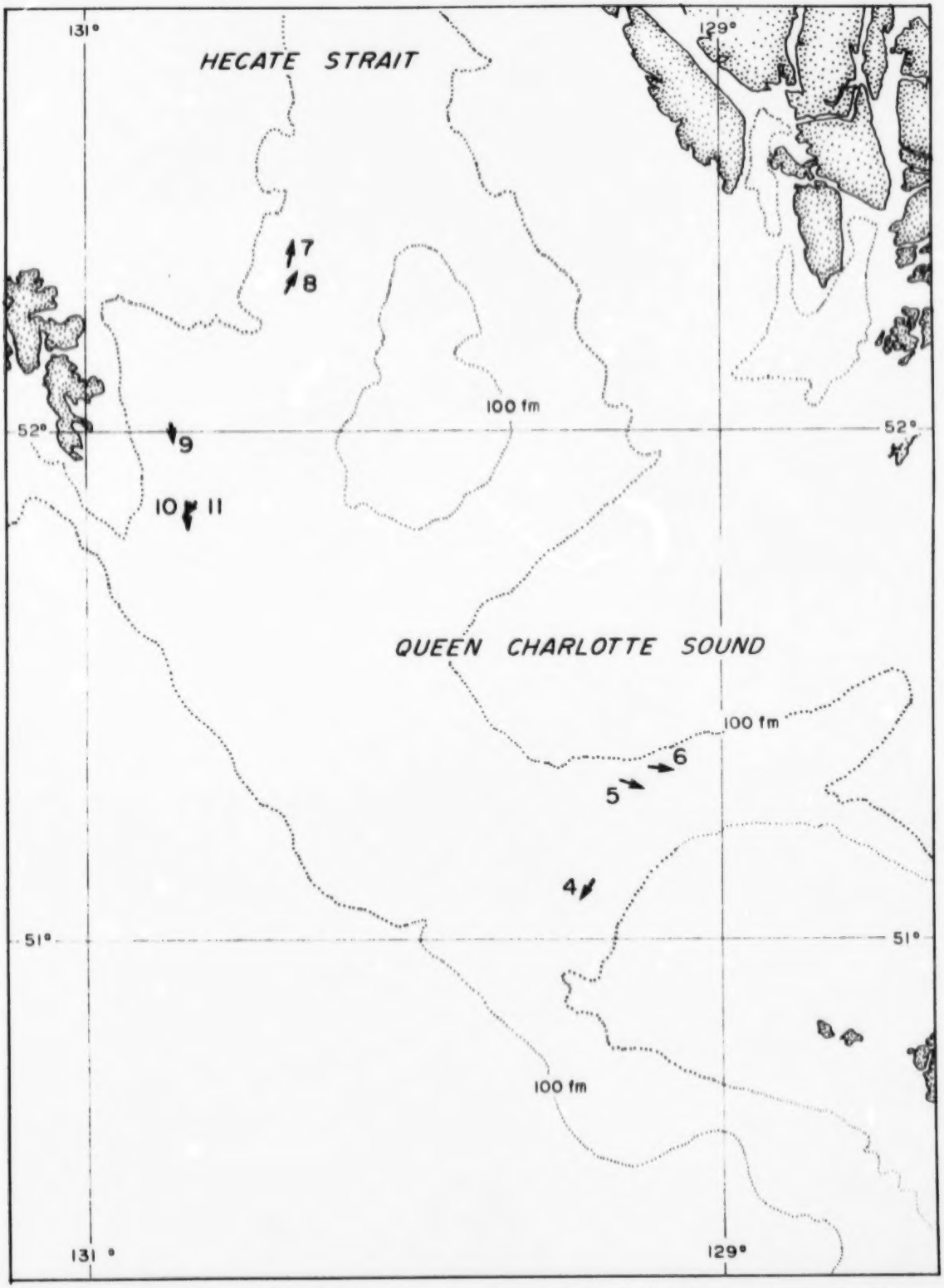

Fig. 2. Location of trawl stations in Goose Island Gully (stations 4-6) and Moresby Gully (stations 7-11), R/V G. B. REED October 21 - November 9, 1985.

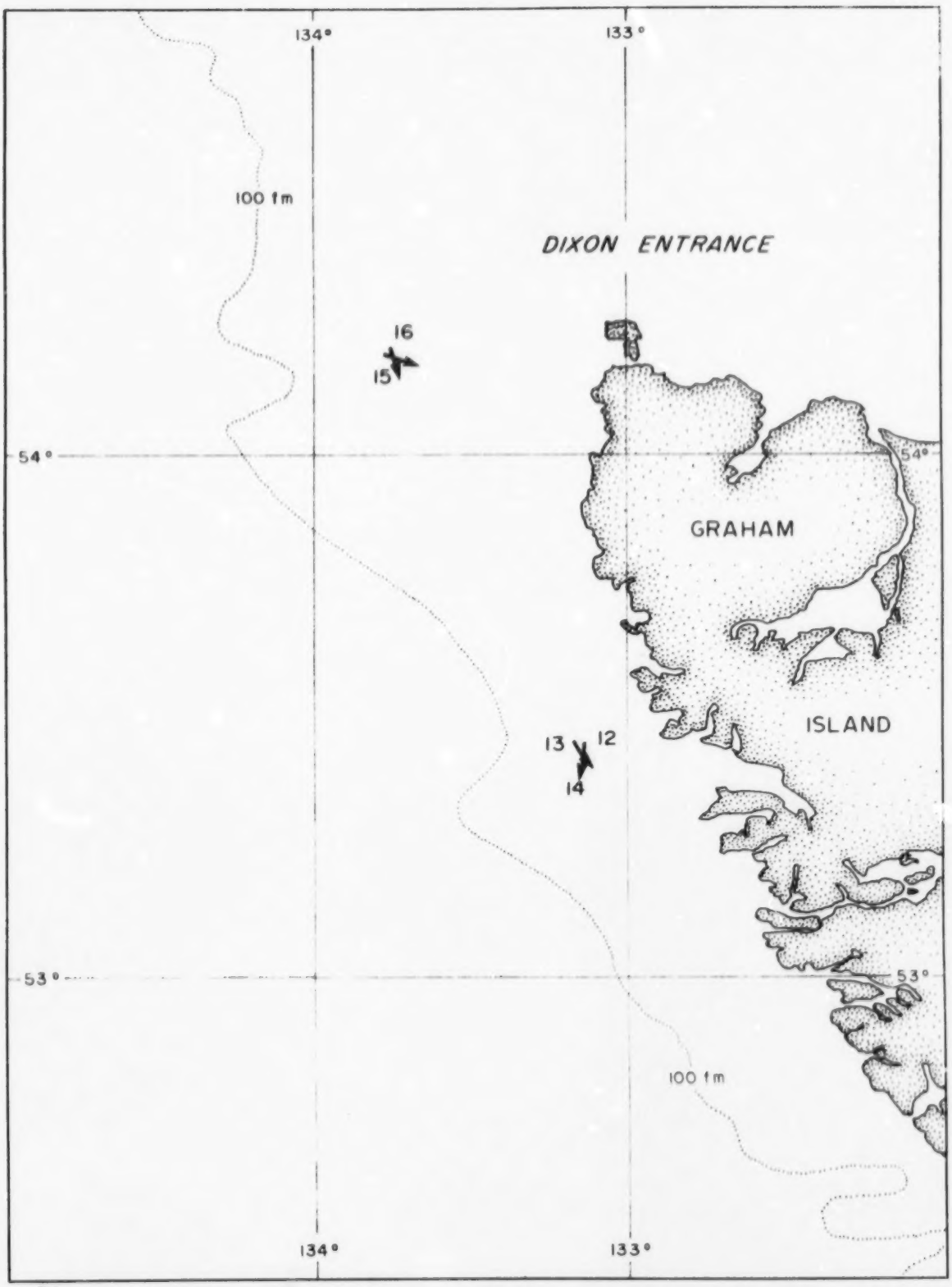

Fig. 3. Location of trawl stations off the west coast of the Queen Charlotte Islands (stations 12-14) and at Langara Spit (stations 15-16), R/V G. B. REED October 21 - November 9, 1985.

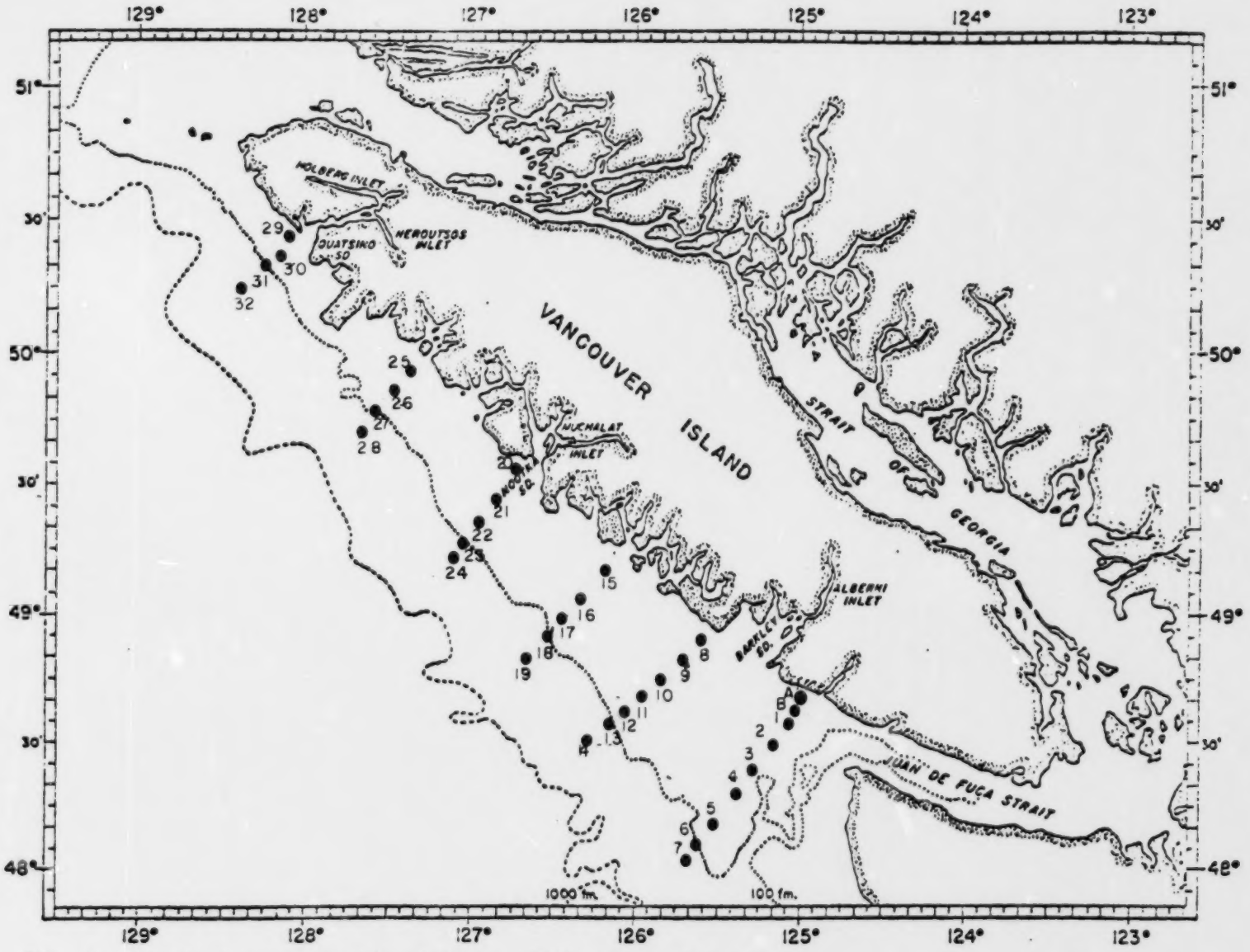

Fig. 4. Standard oceanographic stations off Vancouver Island.

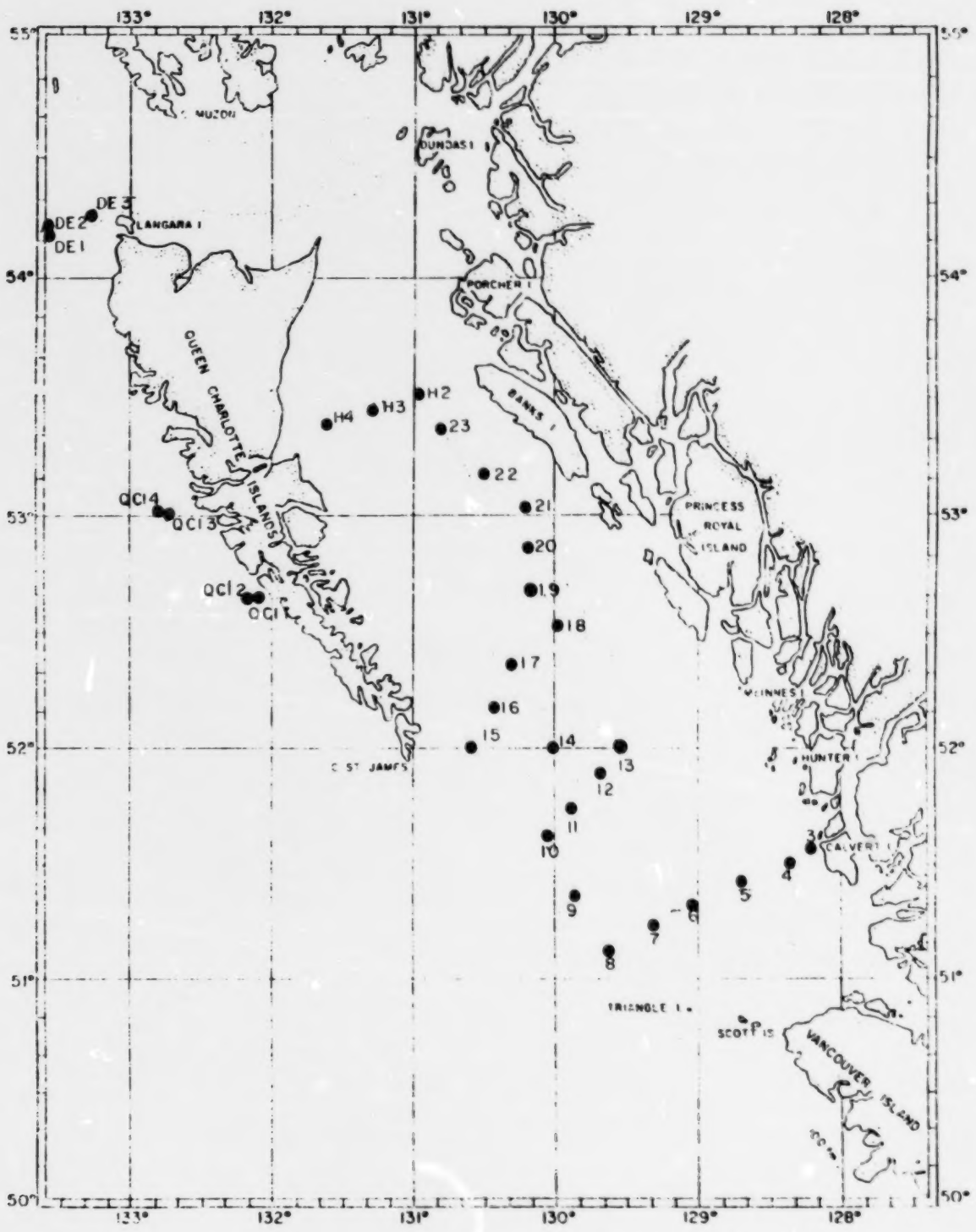

Fig. 5. Standard oceanographic stations in Queen Charlotte Sound, Hecate Strait, Dixon Entrance and the Queen Charlotte Islands.

Appendix Table 1 does not appear in paper, but appears in microfiche form at the back of this report.